SMBNEP Comprehensive Monitoring Program
Chapter 6 – Sandy Shores

Habitat Introduction

Sandy shores are complex, highly dynamic environments that link marine and terrestrial ecosystems and provide important ecological functions, including increased coastal resilience. Sandy shore habitats include the intertidal beach, coastal strand, fore dunes, coastal dunes, and stabilized dunes. Sandy shores are the most prominent habitat along the Santa Monica Bay shoreline, extending for over fifty kilometers (Dorsey et al. 2020). Santa Monica Bay beaches are highly prized for their social uses and their substantial contributions to California's economy, including receiving over 70 million visitors annually, and are also unique and biologically diverse ecosystems when in a more natural, less disturbed condition (Dugan et al. 2015).

When evaluating these habitats, the Bay can be divided into northern and eastern regions at the point where Sunset Blvd meets the Pacific Coast Highway (PCH). In the north (north of Sunset Blvd to the Ventura County line), the shoreline is backed by the Santa Monica Mountains, compressing development between this and a narrow intertidal beach. Exceptions exist where creek mouths have created more expansive sandy habitats, such as at Topanga, Malibu Lagoon, and Zuma Beach. Sediment for beaches in this region historically came from several short, steep, mostly seasonal streams and erosion of the unstable cliffs and bluffs east of Point Dume. However, sediment input to the system has been reduced dramatically east of Point Dume due to development, including cliff stabilization and dams on Malibu Creek (Orme et al. 2011). Alongshore transport of sediment in this region is south and eastward. In the east (south of Sunset Blvd to the Palos Verdes Peninsula), the shoreline is backed by coastal bluffs north of the Santa Monica pier, and several dune systems to the south. However, development now obscures most of these dune systems sitting between beaches and the bluffs. Historic sediment sources for beaches in this region came from Ballona Creek or the Los Angeles River, when it flowed out through Ballona Creek. Now, despite stormwater runoff during rains and some dry-weather flow, Ballona Creek delivers little sediment to nearby beaches due to the heavily channelized watershed and trapped sediments behind debris basins in the upper watershed (Orme et al. 2011).

Sandy shore habitats are naturally dynamic. On natural intertidal beaches, sand is eroded in winter and deposited in summer, resulting in dramatic seasonal changes in beach slope and width. In the coastal strand and dune habitats, wind shifts the sand around, causing formation and migration of the dunes over time. In the Bay, sandy shore habitats were historically highly productive. The intertidal beach supported up to 90 species of macroinvertebrates, including two clams that previously supported commercial fisheries (Allen and Pondella 2006). Intertidal beaches are also important spawning habitat for the

California grunion (*Leuresthes tenuis*), an endemic fish in the silverside family (Martin 2015), while dozens of species of shorebirds use intertidal beaches and the coastal strand for foraging or roosting. These habitats are also nesting sites for two federally listed birds, the California least tern (*Sterna antillarum browni*, endangered) and the western snowy plover (*Charadrius alexandrinus nivosus*, threatened) (Carreker 1985, Lafferty 2001, U.S. Fish and Wildlife Service 2007). Finally, dune habitats are home to rare wildlife species, such as the silvery legless lizard (*Anniella pulchra*) and endangered El Segundo blue butterfly (*Euphilotes battoides allyni*), that live in native vegetation.

However, sandy shore habitats are also some of the most disturbed in the Santa Monica Bay and its watershed. Marina development and other major coastal construction projects have altered our historic shorelines (Flick 1993). All the stabilized back dune systems are disconnected from beach habitats by roads and parking lots (Cooper 1967). In many places, the shoreline has been further altered to maximize the width of the dry sand areas through beach nourishment or other physical alterations that are beneficial for recreational uses, but also bury coastal strand habitats (Flick 1993, Orme et al. 2011). Regular grooming (raking and grading of sand) to remove trash and kelp wrack prevents the establishment of coastal strand plants and the formation of coastal dunes. Infrastructure, such as roads, bike paths, volleyball courts, groins, and jetties, also alters the natural movement of sand and formation of dunes. These activities have left most sandy shore habitats in the Bay less able to provide physical and ecological services, dramatically reducing the number of species they support (Dugan and Hubbard 2009). Recent research on storm and El Niño impacts to shorelines warns of climate change related effects in the future due to sea level rise and coastal erosion.

Southern California beaches, in general, are very different than they were a century ago. Much of the Southern California coastline is now armored (e.g., seawalls, riprap), a majority of the easily accessible beaches are mechanically raked and graded, and the sediment deficit for beach sand budgets has been over a million cubic meters of sand per year for more than 50 years (Gittman et al. 2015; Orme et al. 2011). The understanding of physical dynamics and long-term changes in the extent of beach habitats in Southern California is relatively detailed and advanced. The interpretation of decades of aerial photographs and comparisons to mapping done from the 1850s to the 1870s has provided a good basis for quantifying beach change over time (Orme et al. 2011). The effects of reductions in sediment supply caused by dams to the state's beaches have also been quantified (e.g., Willis and Griggs 2003).

Ecological research in the region has allowed the identification and quantification of two of the major stressors on sandy beach ecosystems in southern California: beach grooming (Dugan et al. 2003), and coastal armoring (Dugan et al. 2008). A major gap in our understanding of the ecological impacts of beach nourishment is limiting the ability to inform current coastal policy. A major, long-term (~1970–1978) ecological survey effort of many beaches in the Southern California Bight followed the 1969 Santa Barbara oil spill.

Many of these sites have been re-surveyed in recent years, and comparative analyses of changes in the intertidal species richness of beaches across more than three decades suggest that local-scale human impacts are a stronger driver of biodiversity loss than regional processes (Schooler et al. 2017). Santa Monica Bay's beaches rank very low overall in species richness, comparatively. Assessing how far the baseline has shifted for beach ecosystems over longer periods is challenging. However, a historical ecology analysis by Hubbard et al. (2013) of distribution patterns for two species of beach invertebrates over several decades in the Bight found that they had been extirpated from about 60% of their historically occupied beaches in the Bight, including all former sites in the Santa Monica littoral cell.

While research in Southern California on shoreline processes, restoration activities, and impacts caused by human activities on the ecological processes of intertidal beach habitat is extensive, ecological monitoring across all the zones in sandy shore habitat and encompassing the full range of ecosystem services is limited in Southern California, and particularly in Santa Monica Bay (Foreman et al. 2015). More comprehensive monitoring is needed to establish baselines and impacts to sandy shore habitats and track trends. Outreach and education, including citizen science programs, are also needed. To help provide some basic data, a pilot citizen science program, called All Ashore, is being developed. In this program, scientists collaborate with volunteers to assess the natural features of beaches, human uses, current management policies, and coastal development. These include the physical aspects of the beach, types of beach zones present, plants and animals on the beach, and human uses and influences on the ecological functions. Professional-level quantitative data are also needed to provide more fine-tuned information. Monitoring of sandy shore habitats in Marine Protected Areas will help, but these studies are limited to intertidal beach habitats in specific locations. The 2015 State of the Bay (SotB) Report identified a significant need for quantitative scientific ecological monitoring in sandy shore habitats and an overall data gap for this habitat type.

In recent years (2016-2020), LMU's Coastal Research Institute and TBF have initiated several new programs to collect sandy shore data. One effort led by Dr. John Dorsey of LMU / CRI aims to characterize the biological and physical conditions of Santa Monica Bay beaches through opportunistic surveys along a broad geospatial area. Additional efforts led by TBF collect long-term monitoring data associated with specific beach restoration and living shoreline projects at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches, with several other locations seeking funding.

Much of the introductory information for sandy shores in this chapter was replicated and updated slightly from information in the 2015 SotB Report (Foreman et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of sandy shore habitat in the NEP study area?
2) How has condition of this habitat changed over time?

3) What are remaining data gaps associated with sandy shores?

TAC – should a section be inserted here for specific monitoring program objectives tied to sandy shores? There is a general section in the CMP introduction that includes overall CMP monitoring program objectives.

Indicators

Utilizing indicators helps track changes in the environment, and consistency in indicators over time allows for long-term trends in habitat condition to be evaluated. The sandy shore habitat includes 15 indicators across four categories which will be used to detect changes in the environment (Table 6.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales.

Table 6.1. Indicators for sandy shore habitats in the Santa Monica Bay region.

Indicator Category	Sandy Shore Indicators
Habitat Extent	Area of Sandy Shore Habitats
Biological / Ecological Condition	Nursery and Habitat Provisioning for Fish
	Foraging Function for Birds
	Nursery and Roosting Function for Rare Birds
	Invertebrate Food Web Support Index
	Native / Invasive Flora
Stressors	Anthropogenic Infrastructure / Beach Hardening
	Habitat Protection
	Human Activities
	Beach Management Practices
	Beach Water Quality
Climate Change Vulnerability	Shoreline Erosion / Topography Change
	Surface Zone Water Temperature
	Coastal Flooding
	Hazard / Disturbance Response

TAC – Do we provide details / definitions for each indicator in the table above in a list here or is it not necessary? E.g.,

Area of Sandy Shore Habitats –

Surfzone Fish Community –

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of beach habitats providing ecosystem functions by type (e.g., coastal strand, dunes, etc.); mapping and proportions of human use or specific recreational areas versus biologically relevant or sensitive habitat areas; and location and mapping of back dune systems. Various geospatial layers can be used to inform this indicator, including grooming data from LACDBH, mapping data from CRI's beach characterization study, and other mapping data such as opportunistic research programs conducted by USC Sea Grant or other entities. Aerial photographs such as from the California Coastal Records Project (californiacoastline.org) may also serve to inform this indicator or others below. In general, except for seasonal variations in beach width and sediment movement, data layers for habitat extent are unlikely to frequently exhibit substantial changes, but may be updated annually, biennially, or as new policies are put into effect.

For the other three categories of indicators, i.e., biological / ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 6.2, 6.3, and 6.4, respectively.

With the exception of the beach monitoring program led by CRI, data collected to inform trends associated with various indicators are often informed by monitoring or research programs that are conducted opportunistically or not comprehensive throughout the Santa Monica Bay. For example, the UCSB surfzone fish surveys are only conducted on Point Dume Beach, Malibu, and rare bird surveys for California least terns and western snowy plovers are only conducted on beaches they are known to inhabit through roosting or nesting. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state "opportunistic surveys / research" or "N/A" in the frequency fields below as they may not currently be funded programs.

INSERT MONITORING LOCATION MAP(S) AND SEVERAL PHOTOGRAPHS

Table 6.2. Biological / Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Nursery and Habitat Provisioning for Fish	Median grunion run size over time; grunion run distributions and geographic range	Pepperdine University (Grunion monitoring program) led by Dr. Karen Martin	Runs monitored by citizen scientists several times annually between March and August
	Abundances and densities of foraging surfzone fish	UCSB surfzone data (nearshore seines and motion cameras) collected in MPAs and surrounding areas led by Dr. Jenny Dugan (Point Dume SMR)	Twice annually (summer and fall) at Point Dume SMR
		Vantuna Research Group surfzone data (Occidental College) collected at several locations in the Bay	Annually
Foraging Function for Birds	Presence and abundances of resident and migratory bird species	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
		e-bird data (quality control checked citizen science)	N/A
		Audubon Christmas Counts (long-term data)	Annually in winter
	Bird activity observations	Some data collected by TBF / CRI associated with living shoreline projects; research projects (not comprehensive)	Opportunistic surveys / research
Nursery and Roosting Function for Rare Birds	Western snowy plover and California least tern abundances (roosting) over time	Plover and tern abundances and locations conducted by Audubon Society and Ryan Consulting	Monthly surveys
		e-bird data (quality control checked citizen science)	N/A

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
	Western snowy plover and California least tern number of nests and successfully fledged chicks	Breeding bird surveys conducted by Audubon Society and Ryan Consulting	Monthly surveys during breeding season
Invertebrate Food Web Support Index	Presence and diversity of native invertebrate fauna	Schooler, Hubbard, and Dugan unpublished data (UCSB); MPA monitoring data (UCSB)	Opportunistic data; twice annually (summer and fall) at Point Dume SMR (MPA)
	Sand crab and beach hopper zones in intertidal areas	Schooler, Hubbard, and Dugan unpublished data (UCSB); MPA monitoring data (UCSB)	Opportunistic data; twice annually (summer and fall) at Point Dume SMR (MPA)
	Food web support index	N/A	N/A
	Indicator species (e.g., bean clams as an indicator of warmer waters)	Opportunistic surveys / research	N/A
Native / Invasive Flora	Presence / cover of native vegetation; presence / cover of invasive vegetation	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	Wrack cover / presence by species; presence of invasive *Sargassum horneri*	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches

Table 6.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Anthropogenic Infrastructure / Beach Hardening	Percentage of shoreline that has been armored; number, location, and type of infrastructure (e.g., pier, jetty, groin)	Dorsey beach characterization study results and mapping data; NOAA Office of Oil Spill Response and Restoration (Environmental Sensitivity Mapping)	Once and then tracking as infrastructure is changed over time
	Percentage of beach shoreline with beachfront infrastructure; number and location of structures and beach facilities	Dorsey beach characterization study results and mapping data; NOAA Office of Oil Spill Response and Restoration (Environmental Sensitivity Mapping)	Once and then tracking as infrastructure is changed over time
Habitat Protection	Percentage of habitats under various levels of protection (e.g., grooming practices, MPA areas)	MPA area data from CDFW; maps of fenced areas (e.g., Santa Monica Beach pilot, Venice Least Tern Colony)	Once and then tracking as practices are changed over time
		Beach grooming data from LACDBH	Once and then tracking as practices are changed over time
Human Activities	Numbers, locations, and types of events on beaches (e.g., camps, cultural events, sports, trainings)	County Beach Commission – groups of over eight people or classes must register	As occurring
	Beach driving and other vehicle disturbance factors	County lifeguard data or LACDBH	N/A
	Off-leash dogs on the beach	County lifeguard data and Audubon records	Opportunistic surveys / research
	Recreational fishing activities	Heal the Bay outreach surveys	Opportunistic surveys / research
Beach Management Practices	Volume of dredge and fill for beach replenishment / nourishment	Army Corps data for locations of dredging and nourishment areas	Every few years or as needed

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
	Seasonal winter berm construction	See LACDBH winter berm report for details on locations	Annually between October and March
	Grunion protection zones / high tide line wrack protection areas	Pepperdine and LACDBH data	Annually between March and August
	Vegetation protection areas	Dorsey beach characterization study results and mapping data	Opportunistic surveys / research
	Fire safety, rings, and illegal bonfires	State Parks and LACDBH	??
Beach Water Quality	Long-term FIB trends	Heal the Bay Beach Report Card data; outfall monitoring data by County and City	Daily
	Nutrient inputs and limitations	Opportunistic surveys / research	N/A
	Temperature	SCCOOS Santa Monica Beach shore station	Daily; calibrated monthly

Table 6.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Shoreline Erosion / Topography Change	Beach width (volume) change; accretion / erosion	USGS models; Holland study - SLR/erosion	??
		aerial imagery; remote sensing data / NASA public data sets; LiDAR data over time	Opportunistic surveys / research
		Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	New dune formations	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	Outflow change / storminess	??	??
	Slope and berm morphology (nearshore processes and beach face)	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies; UCSB beach monitoring data	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
Surface Zone Water Temperature	Surface water temperature	SCCOOS SM Pier data; National Weather Service offshore station data	Daily; calibrated monthly
	Larval settlement; animal size / abundances / distribution (PLOS Jaramillo article)	??	??
Coastal Flooding	Sea level rise vulnerability	CoSMoS/OCOF tool for southern California, CRI Site Suitability Model study	Once

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
	Frequency and location of flooding events	King tide citizen science surveys by USC Sea Grant	As conducted; opportunistic surveys / research
	Infrastructure vulnerability	Vulnerability studies conducted by LACDBH (2016 report), City of LA, City of Manhattan Beach, and other coastal municipalities	As completed
Hazard / Disturbance Response	Intensity of disturbances, e.g., aftermath of major storm events; modeling El Niño events and responses	Before / after LiDAR data and scans; side-scan sonar	Infrequent – every few years

Data Sharing and Reporting

Sandy shore monitoring data will be compiled and analyzed approximately every five years associated with the production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers and summaries will be publicly available upon request. When possible, data will be incorporated into public databases such as through the grunion monitoring portal (grunion.org) or other similar public data sharing portals.

Data Gaps and Future Studies

Former data gaps identified for sandy shore habitats by the 2015 SotB Report were extensive for sandy shores, including the indicator and metrics associated with the habitat extent category. However, significant progress has been made in recent years on the characterization of sandy shore habitats in the Santa Monica Bay led by Dr. John Dorsey, LMU and CRI, and by TBF. These new data will be reflected in SMBNEP's next SotB Report. Additional data gaps identified in the 2015 SotB Report include all or portions of the following indicators: beachfront protection, areas of development, armoring trends, sediment supply, beach management practices, nutrient inputs, invasive species, and trend data for native flora and fauna. Though some of these indicators have been evaluated and updated for this revised CMP, many of them continue to be reflected in Tables 6.2-6.4 as important condition metrics. Several new metrics associated with the new "climate change vulnerability" category are also identified in the tables above as data gaps (e.g., larval studies associated with surface water temperature, comprehensive assessments of sediment change or movement, and many others such as nearshore bathymetry studies or detailed information on human impacts).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 6.2-6.4, as well as additional new studies that could further support the evaluation of the key indices for this habitat. New studies that are recommended include building on observational data for extreme tide events, adding monitoring stations or targeted research for many of the indicators above (e.g., surfzone fishes), higher resolution / better geospatial coverage for invertebrate taxa data, more detailed spatial / frequency information on beach best management practices, and incorporation of new modeling efforts. Innovative ideas such as 3D mapping to detect shoreline change or dune formation, or single-beam or side-scan sonar in the nearshore environment to track seasonal shifts in sediment movement or sediment loss should also be explored. Lastly, developing indices and a rapid assessment framework for sandy shore surveys that could be applicable across the Southern California Bight or even standardized at the state level would allow for additional cross-comparisons of data and consistent analyses.

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